ANALOG DEVICES

AN-139
APPLICATION NOTE

ONE TECHNOLOGY WAY • P.O. BOX 9106 • NORWOOD, MASSACHUSETTS 02062-9106 • 617/329-4700

A Low-Voltage Power Supply Watch-Dog Monitor Circuit

by Mike Jachowski

A simple circuit, as shown in Figure 1, consisting of only a reference diode and a matched PNP transistor pair, the MAT-03, can be used to monitor low voltage power rails such as a +5V logic supply. This is useful in microprocessor-based systems using either battery backed-up CMOS or EEPROM memory. The monitor prevents inadvertent writing to the memory as the rest of the digital circuitry turns off with a falling +5V supply. The problem with using conventional comparators to perform this function is that there is no guarantee of the state of the device's output as the +5V supply falls below the comparator's own operating range. Although micropower op amps can handle low supply voltages in such applications, their response times are usually far too slow to protect the memory. The circuit of Figure 1 solves both of these problems. It provides a 700ns response time and maintains an accurate output with a supply voltage as low as 1.7V.

The monitor provides a logic HIGH output warning signal when the supply voltage falls below a preset trip-point voltage that is determined by the relationship:

$$(V_{CC})\ \frac{R_4}{R_4 + R_5} = 1.23V$$

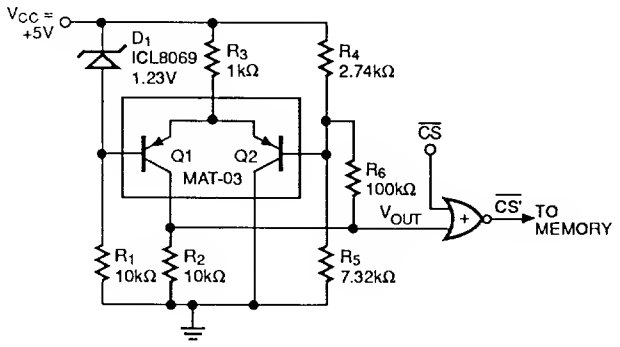

FIGURE 1: *A temperature-compensated reference diode and a matched PNP transistor pair are used to accurately detect a low supply voltage and disable inadvertent WRITE operations to memory.*

During normal V_{CC} at +5V operation, the voltage across resistor R_4 is 1.36V and hence does not trip the comparator. At this point transistor Q_2 turns ON and Q_1 turns OFF, and the comparator outputs a logic LOW. As V_{CC} drops below 4.5V, it trips the comparator, causing Q_1 to turn ON, pulling the Q_1 collector, and therefore the comparator output, HIGH.

Resistor R_6 provides approximately 60mV of hysteresis to guarantee clean HIGH to LOW transitions. The oscilloscope photograph in Figure 2 shows the comparator's response time to be about 700ns with a step change in the +5V supply. Figure 3 shows the comparator's output as the power supply ramps between +5V and ground. In both cases, the trip-point was set at 4.5V.

If an active LOW output is required, the comparator circuit can be modified as in Figure 4 which provides an active LOW output upon crossing the threshold. The circuit's operation is identical to that of Figure 1 except now a matched NPN transistor pair, the MAT-01, is used as the comparator. This produces an output LOW for $1.7V < V_{CC} < 4.5V$, and a HIGH output for $V_{CC} > 4.5V$. Such a circuit is useful for resetting systems if a power fault takes the +5V supply below its operating limit.

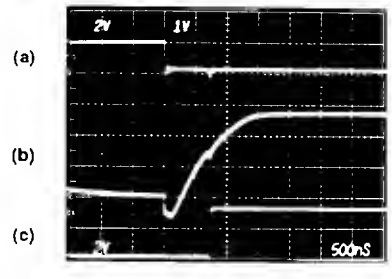

FIGURE 2: *The oscilloscope shows the rise time of the comparator's output, (b), as the supply makes a step change from +5V to +3V, (a). The total delay from supply step to memory disable, (c), is only 700ns.*

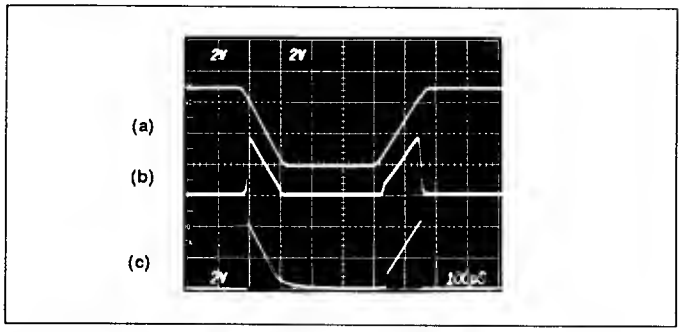

FIGURE 3: *For non-volatile memory applications, the comparator's output, (b), goes HIGH as the +5V supply falls below 4.5V, (a), and stays HIGH as the supply continues to fall toward ground. The comparator does not lose control until $V_{CC} \leq 0.6V$. This keeps the memory disabled, (c), until the supply has safely disappeared.*

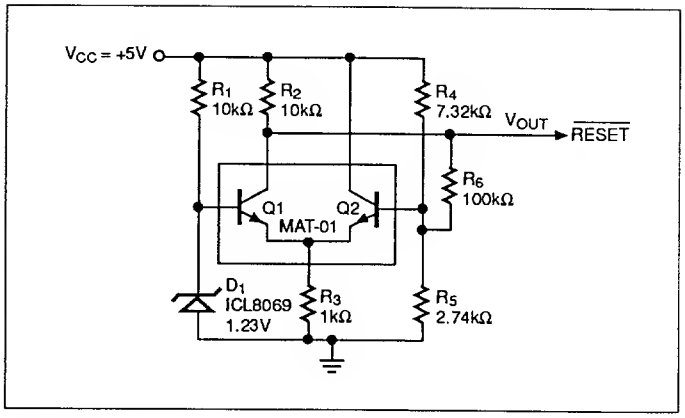

FIGURE 4: *The same circuit can produce an output with opposite polarity by using a matched NPN transistor pair, the MAT-01.*